

imagined, the *Rhipiphorus*-larva ceased to feed before it had drained the juices of its victim to the point of death; the wasp-larva, being at a stage of its existence when it no longer eats, does not, of course, avenge itself. The struggles of the wasp-larva in these uneasy circumstances, and its semiflaccid condition, would easily account for, and render possible, its change of position in the two instances in which that had occurred.

The difficulties which have surrounded the elucidation of the life-history of *Rhipiphorus* may all, I think, be traced to the very short interval that elapses between the laying of the egg and the arrival of the insect at the pupal state. They appear to assume the pupal state almost as soon as the surrounding wasp-grubs; yet the eggs were only laid when these latter were beginning to spin. This allows a very brief period during which they must be found, if these stages are to be observed. Mr. Murray has failed to do so, probably because he did not examine the nests until such a period had elapsed after the nests were taken. I also failed, because, when my opportunities were most abundant, I did not know what to look for. As a similar instance among the *Chrysides*, I may mention the egg of *Chrysis neglecta*, which I have never been able to find. I find young larvæ only, and have satisfied myself that the egg-state does not last as much as twenty-four hours. In the instance I have mentioned above of *Chrysis ignita*, the egg-state cannot have lasted so long.

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XX.—*Concluding Observations on the Parasitism of Rhipiphorus paradoxus.* By FREDERICK SMITH, Assistant in the Zoological Department of the British Museum.

WITH some degree of hesitation, I venture to reassert my belief in the views I put forth in reply to Mr. Murray's first paper on the relations between wasps and *Rhipiphori*. I have some fear of being considered dogmatic, and of not duly weighing the arguments offered to my notice by my friend Mr. Andrew Murray. I must, however, confess myself to be unconverted by his arguments, and unable to arrive at the same conclusions that he does when commenting upon the various phenomena which were presented to him when examining the comb of a wasps' nest. It will perhaps be a matter of astonishment that he has failed in his endeavour to bring me round; and it is equally surprising, but at the same time consolatory, to find Mr. Murray expressing the opinion that, should a larva of *Rhipiphorus* "fall upon a larva of the wasp,

of course there is nothing to be surprised at in its eating it." In this instance, at least, we most cordially agree.

I will endeavour fairly, and I hope without bias, to answer the numerous questions offered for solution. I readily agree, then, in the instance in which Miss Ormerod observed two eggs in the same cell, one at the bottom, the other attached a little way within, that in all probability one was the egg of the wasp, the other that of the parasite; but I do not consider this to be necessarily so: I have myself found two, and, I believe, even as many as three, eggs in a cell, in autumnal nests—that is, at that period of the season when the nest is crowded with the three sexes; and I am quite sure that such nests contained no *Rhipiphori*. I never had the good fortune to find a nest infested by the parasite.

Mr. Murray thinks it likely that I can inform him how the larva of the wasp comes out of the egg-shell. This term is scarcely applicable to the eggs either of wasps or bees: shell there is none; and the thin skin in which the contents are enclosed never appears to be cast off by the larva. At one end I have first observed, in the process of development, the gradual formation of a head, while the rest of the envelope I have believed to become the skin of the larva itself. Whether I am right in this or not, future investigation may decide; but I know that the late Mr. Newport, at one time, was of the same opinion.

The first question I am asked to reply to is one that I am not prepared to answer; but whether the larva of the wasp is fed, after being hatched, before it reaches the bottom of the cell, or not, in no way affects the main question. But this question is put in juxtaposition with that of "How about the young *Rhipiphorus*-larva? is that fed too?" Now the inference is obvious—the egg of the wasp and that of the parasite are hatched at the same time. Mr. Stone has told us that in the instance in which he observed the larva of *Rhipiphorus* feeding upon that of the wasp, it was of minute size (that is, recently hatched); and the wasp-larva at that time was full grown. A question follows as to what the larva of the parasite is like. Mr. Stone has given a description of the larva amply sufficient to distinguish it from that of the wasp: he says it is "more deeply furrowed than any larva with which I am acquainted;" it has also "a longitudinal furrow down the back." To this I may add, as I have a larva before me, that it is divided into twelve segments, the apical one having an anal tubercle or style: I include the head in this number; and therefore, if the anal tubercle were counted as a separate segment, it would increase the number to thirteen—

the normal number. It is also furnished with six pairs of spiracles.

Mr. Murray says the description is imperfect, since it is not stated whether the larva has feet or not—"a not unimportant point when the question is whether the larva passes a nearly motionless life in one cell, or a roving one." But there is no such question before us. It feeds upon a single larva in a closed cell, we are informed; there is no travelling about "like a Blondin," neither is there any chance of its being "gobbled up by the big wasp-grub."

It is stated that "we all know (that is, all entomologists know) how soon a larva freshly excluded from the egg shrivels up if its food is not at its mouth the moment it comes out." Now Mr. Murray does not appear to be aware that some parasitic larvæ live for days, nay, even for weeks, until they are conveyed to, or by chance find, the nourishment suitable for their sustenance. The late Mr. George Newport, in his paper on the oil-beetle, has recorded the fact of larvæ living without food for a considerable length of time. He writes, "I saw most of the larvæ leave the egg as early as five o'clock in the morning. They were confined in a tin box for several days; after remaining ten or eleven days, many of them crept beneath the lid." He also mentions other larvæ that he kept nine days, but which were perfectly healthy and active, although they had not taken any nourishment. I have also kept *Meloë*-larvæ for a fortnight in a perfectly active condition without food; also larvæ of *Melittobia*, a bee-parasite: the larvæ of *Monodontomerus*, a parasite upon *Anthophora*, can exist for days without food; and I will just refer to one other parasitic larva, that of *Stylops*: these, when hatched, may be observed perfectly active days after their extrusion from the egg, without nourishment.

I am asked if I "think that a meal of one animal can suffice to nourish another into as great dimensions as the animal eaten." I reply, first, that in the case before us the animals are not of the same dimensions; both are before me, and I see in the wasp a much more bulky insect than the *Rhipiphorus*. I am comparing a worker wasp with its parasite bred from a worker-cell; I have also a pupa from a cell of the queen wasp, and I challenge Mr. Murray to produce a specimen of a *Rhipiphorus* as large as a queen wasp. What will Mr. Murray say when he compares the parasite of *Anthophora* (*Meloë*) with the bee itself? and yet its larva is said to feed upon the larva of the bee; some authors suppose it to feed upon the food stored up by the bee. Now it is clear that *Meloë*, an insect full twice the size of *Anthophora*, is nourished upon the same

amount of food necessary for the bee, or it is nourished upon its larva. "If we look," Mr. Murray observes, "at the little black deposit of digested debris at the bottom of the wasps' cells, we find fragments indicating the consumption of hundreds of insects not much smaller than themselves." This statement is intended to prove the impossibility of *Rhipiphorus* being nourished upon a single wasp-grub. In my opinion the fragments are merely fragments of portions of insects with which the wasp-larva had been supplied; these fragments are no proofs of the wasps having eaten entire insects. A wasp frequently carries off a large blowfly; but what proof is there existing to show that the entire fly becomes the food of a single larva? I imagine such an inference will scarcely be accepted as sufficient evidence to overthrow the accumulation of facts recorded by a naturalist who is no longer living to support his own opinions.

It is assumed that Mr. Stone made his observations on a larva situated in the middle of a comb, or at any rate surrounded by other cells containing larvæ, and that, having found that which he had searched for during several years, he took so little precaution in making his observations, that, having seen the parasite feeding, he went away, returned, looked into another cell in which was a mature larva of the parasite, and in this manner was led to record a series of mistaken observations. I will venture to affirm that, had Mr. Murray been acquainted with Mr. Stone's methodical way of making his observations, he would have felt assured of such a mistake being impossible. The larvæ of *Rhipiphori*, it is affirmed, should always be found in sealed cells, if one wasp-grub is sufficient to nourish them. Certainly, so they should; and be it observed that Mr. Stone, on taking out the wasps' nest, proceeded to open the "closed cells." He afterwards took thirteen nests which each contained *Rhipiphori*, either in the larva-, pupa-, or perfect state; he afterwards records that, on opening some "closed-up cells" appropriated to queens, he found one larva and one pupa. I contend that the fair inference to be drawn from this is that all were in closed cells. Now it is quite possible that the larvæ (he does not say what proportion these bore to the pupæ and perfect insects) were all full-grown, having fed upon the grubs of the wasp: of course they would then be solitary in the cells. Mr. Murray asks what the mass of larvæ were doing in cells by themselves. There is no mass spoken of by Mr. Stone. And will Mr. Murray venture to affirm that, as soon as a larva is full-fed, it immediately assumes the pupa state? If he will, he will do so in the face of an overwhelming mass of evidence to the

contrary. I affirm, from actual observation, that they do not.

It is stated that, if Mr. Stone's observation is correct, we should never see any half-grown larvæ; there should be no medium between a minute one and a full-grown one, except during the forty-eight hours at which it is at its meal. I quite agree to the cases of exception. Mr. Stone has recorded the instance in which he saw a "minute" one, and also one which he calls "small:" the latter is in my possession; its length is 3 lines, that of the wasp to which it is attached is  $5\frac{1}{2}$  lines. Mr. Murray has seen these larvæ, and he states in his paper that "both are well grown."

With regard to the difference of size in perfect examples of *Rhipiphorus*, I find the difference to be exactly parallel to that which is observable in worker wasps. I have six examples in my collection; they differ in size as follows:—9, 10, 11,  $11\frac{1}{2}$  millimetres. Worker wasps vary in size from  $5\frac{1}{2}$  lines to 7 lines.

It is stated that the only cases of alleged attacks upon wasp-larvæ are those recorded by Mr. Stone: this is not strictly correct, since I have, in my former paper, quoted from the Rev. E. Bigg's paper on wasps the statement that Mr. Denison, in several instances, observed them in all stages of their growth. The *Rhipiphorus* is called a fly: this, Mr. Curtis observes, is, no doubt, the *Rhipiphorus* which "deposits its egg upon the grub of the wasp at the moment it assumes the pupa; as soon as the egg is hatched, it devours the grub of the wasp entirely, and itself assumes the pupa and imago form in the cells of the wasp."

Admitting that many particulars are here wanting, and which, no doubt, some intelligent entomologist will furnish very shortly, as several are fully bent upon the investigation, still every candid person will allow that the statement bears strongly in favour of the accuracy of Mr. Stone's observations.

When Mr. Stone opened the closed cell in which he found a wasp-larva attacked by a minute *Rhipiphorus*-larva, Mr. Murray thinks he should have found a wasp-pupa; why, is not stated; but it is assumed, no doubt, that immediately the wasp-grub has spun the silken cap over the mouth of the cell, it momentarily assumes the pupa state. If Mr. Murray has not, I have, and so have hundreds of persons besides, extracted wasp-grubs from closed cells for baits when angling.

It is assumed that possibly Mr. Stone picked a minute larva of *Rhipiphorus* out of a cell and dropped it upon the wasp-larva. "If it fell upon a larva," Mr. Murray observes, "of course there is nothing to be surprised at in its eating it, as



the wasp-grub would have done with it if it had got the first chance." The cells opened by Mr. Stone contained full-grown larvæ of wasps; they had therefore ceased to feed. It is also stated to be "against all rules of probability that the cell should have been opened at that precise juncture of time at which it began its attack." Now I would remind every entomologist that the fact recorded by Mr. Stone offers an explanation, because, although many persons have repeatedly found *Rhipiphorus* in wasps' nests, only two record their having observed the beetle-larva preying upon that of the wasp. And why have they not? The parasitic larva becomes full-fed in forty-eight hours: therefore although full-fed larva have been found, immature ones have seldom been met with.

The parasitic larva is always spoken of as having eaten the wasp-larva, as if it had fed upon some solid substance. If this eating were understood as extracting the soft and semifluid contents, it would be more correct. Mr. Stone made no "ludicrous blunder" when he stated that it inserted its head beneath that of its victim. I see no difficulty in its extracting the entire contents of the larval skin in that position; and I must protest against the supposition that Mr. Stone did not know the head from the tail of a wasp-larva.

I shall only, in conclusion, offer a few remarks upon a passage in which the statement requires both correction and refutation. After alluding to the instance in which Mr. Stone discovered a small larva of *Rhipiphorus* firmly attached to its victim, both being dead, the nest having been taken by destroying the wasps by means of gas-tar, and both having become partially dried, so that, when immersed in spirit, they did not separate, Mr. Murray tells us that he considers this a case of double occupation, similar to those which have come under his notice, and the attachment to be probably nothing more than what may be seen in every bottle of insects sent home from abroad or collected at home, the insects having, in their mortal agony, seized the nearest object with their mandibles. Now I will ask what analogy is there between the perfect insects collected and thrown into a bottle and larvæ so immersed? Have larvæ been observed to attach themselves in spirit? Mr. Stone's larvæ were found attached in the cell, dead and partially dried—in fact, just in the position in which they were when suddenly killed by the gas-tar.

In a postscript, Mr. Murray admits having seen the specimens I have just alluded to, and finds them "presenting *almost exactly* the same appearance as some specimens in the South-Kensington Museum; but he cannot say whether they are merely in juxtaposition or if one has its jaws fastened on

the other; but both are *well grown*." The latter observation is not quite correct, and it is calculated to throw some doubt upon the accuracy of Mr. Stone's words, which are, "I was fortunate in discovering a *small larva* attached to its victim." The size of the parasitic larva is 3 lines, that of the wasp  $5\frac{1}{2}$ ; they have been in spirit since 1865, and were partially dried at the time they were immersed, so that the exact relative size cannot be ascertained; but the present difference between them justifies Mr. Stone in calling the parasitic larva small. I have carefully examined them, and am satisfied of the *Rhipiphorus*-larva being attached to the wasp-larva just below the head; there is no attachment of the rest of its body: I have separated the bodies, and proved it.

The last paragraph of the postscript is entirely suppositional. Mr. Murray has not shown me any of his specimens: I have seen no pupæ with the cast skin sticking to their tail; and if I had, I should only have seen the reverse of what Mr. Stone records, who describes the larva of *Rhipiphorus* as having its "mouth buried in the body of the wasp-larva just below the head."

Let it be distinctly understood that I admit that it is possible, but *highly improbable*, that Mr. Stone has recorded mistaken observations.

From actual observation I know nothing of the subject. I was never so fortunate as to find a nest infested by the parasite; but for some years I had the enjoyment of a close correspondence with Mr. Stone, and I know him to have been a most accurate and careful observer; and, until actual observation prove his statements to be fallacious, I shall have a firm belief in their truth.

## XXI.—*Häckel on the Relationship of the Sponges to the Corals.*

By WM. S. KENT, F.Z.S., F.R.M.S., of the Geological Department, British Museum.

SCIENCE does and always must acknowledge herself indebted to those who unveil the mysteries of nature by demonstrating to us the singleness of purpose and the uniformity of the laws which have been in operation from "the beginning." In the last two numbers of the 'Annals,' Mr. Dallas favours us with a translation of Ernst Häckel's article, published in the 'Jenaische Zeitschrift,' "On the Organization of the Sponges, and their Relationship to the Corals."

Admitting that once, far away back beyond the limits of the Silurian epoch, there in all probability did exist a some-